Clean Air Mercury Rule: Human Health Assessment

Gail Charnley, PhD

28 November 2007

HealthRisk Strategies
Washington, D.C.
www.healthriskstrategies.com

Outline

- Quick review of methylmercury neurodevelopmental effects
- New data on methylmercury & fish
- EPA risk assessment & US exposure levels
- CAMR conclusions regarding methyl-mercury risks after implementation
- Conclusions about methylmercury risks

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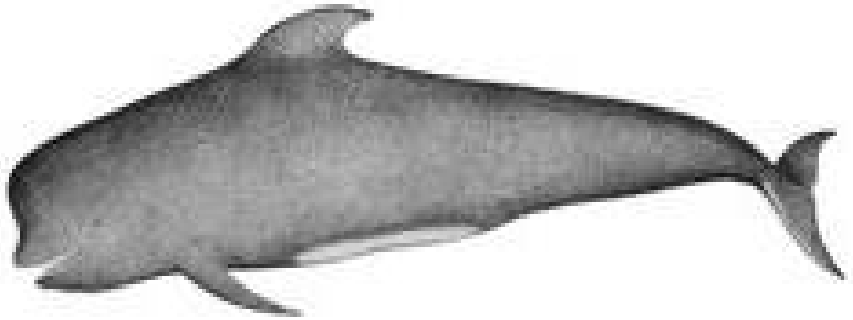
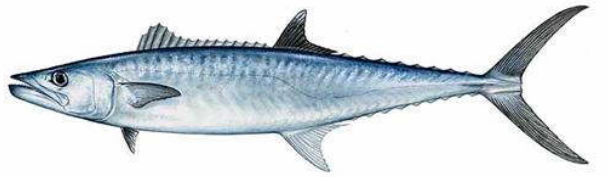
How do we know that methylmercury is a developmental toxicant?

- Minamata Bay– contaminated fish
- Iraq– contaminated seed grains
- Faroe Islands– contaminated whale meat



Benefits of fish?



- Seychelle Islands– greater MeHg exposure than Faroes but no whales in diet
  - No adverse neurodevelopmental effects reported
  - In some cases, children of women who had higher mercury exposure performed better on tests of neurodevelopment
- UK– women eating 2 fish meals or less during pregnancy versus more than 2 fish meals
  - Children of women eating less fish were more likely to have lower IQs & more behavioral problems

Mercury-Selenium Interaction

- Selenium– essential component of critical enzymes that support brain function
- Fish– rich source of dietary selenium
- Mercury– binds selectively with selenium, reducing its availability for selenoenzymes
- Pilot whales– Se/Hg ratio = 0.25
- Fish– Se/Hg ratio = from 3 (swordfish) to 22 (sardine)

US EPA Reference Dose

- Based on solely Faroe Islands data
- Based on analysis that does not account for other contaminants, e.g. PCBs
- Lower (more stringent) than other governments' and organizations' exposure limits, which include Seychelle Islands data and different uncertainty factors
  - Lower exposure limit means more fish exceed limit and more people thought to be at risk

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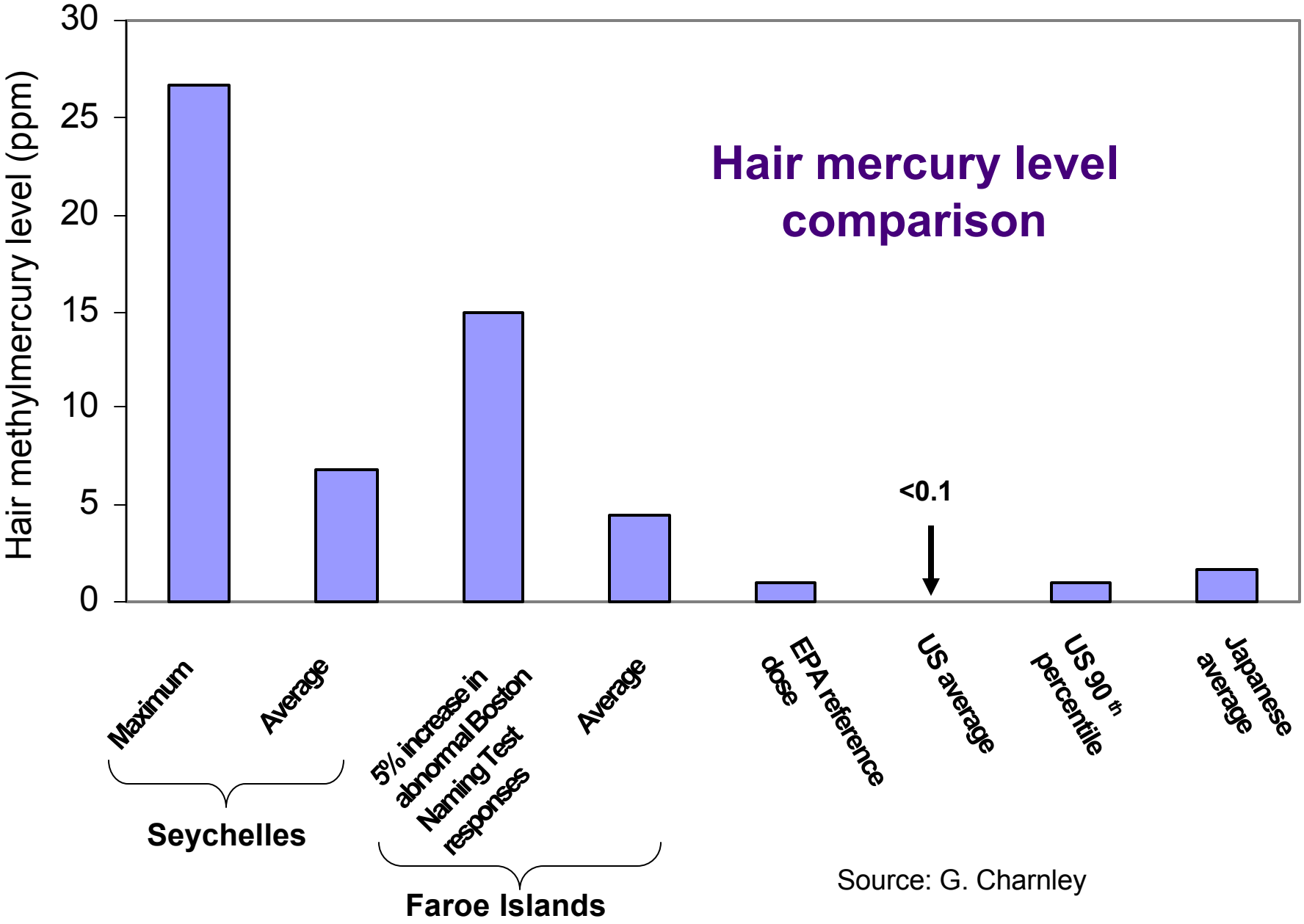
Exposure Limits for Methylmercury

	Organization[a]				
	ATSDR	**EPA**	**RIVM**	**WHO**	**ICF/TERA**
Exposure Limit[b,c]	0.3 chronic MRL	0.1 RfD	0.1 TDI	0.23 TDI	0.3 to 1 RfD
Study	Seychelles	Faroes (primarily)	Seychelles	Seychelles, Faroes	Seychelles
Study Dose[b]	1.3	0.9 to 1.5	1.3	1.5	0.9 to 3
Uncertainty Factor[d]	4.5	10	10	3.2	3
Year	1999	2001	2000	2003	1998

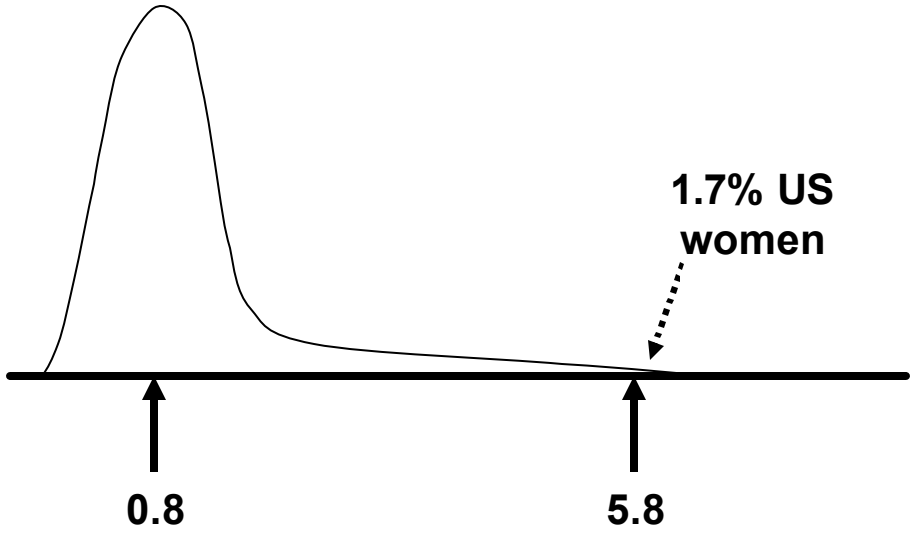
a) ATSDR, Agency for Toxic Substances and Disease Registry; EPA, Environmental Protection Agency; RIVM, National Institute for Public Health and the Environment, The Netherlands; WHO, World Health Organization; ICF, ICF Inc.; TERA, Toxicology Excellence for Risk Assessment
b) Exposures expressed in units of micrograms methylmercury per kilogram body weight per day
c) MRL, minimal risk level; RfD, reference dose; TDI, tolerable daily intake
d) Uncertainty factors are used to lower the acceptable exposure level to the extent considered protective of nearly all people.

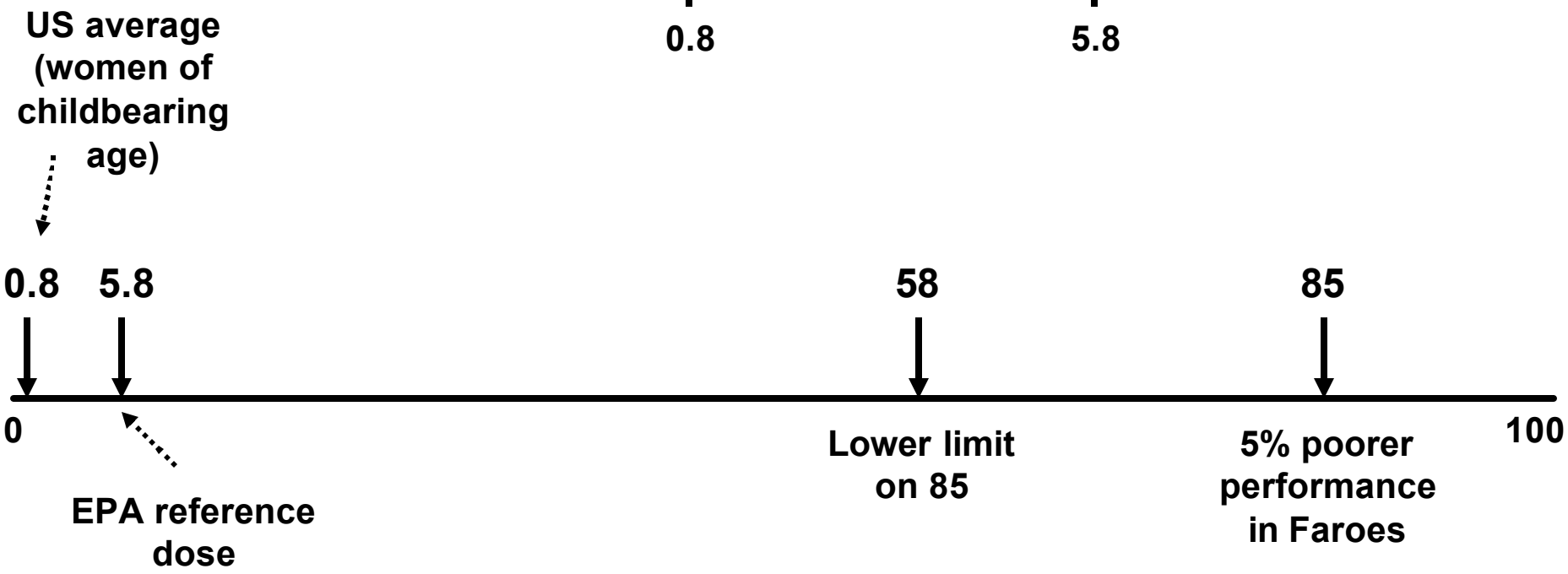
Source: Based in part on TERA/ITER (2005)



Source: G. Charnley

Blood mercury level comparison





Blood mercury concentration (µg per liter)

Source: G. Charnley

Clean Air Mercury Rule

- First-ever federal rule to permanently cap and reduce mercury emissions from coal-fired power plants
- When fully implemented, CAIR & CAMR will reduce utility emissions of mercury from 48 tons/year to 15 tons/year, ~70% reduction
- Will significantly reduce the majority of coal-fired power plant mercury emissions that deposit in the US

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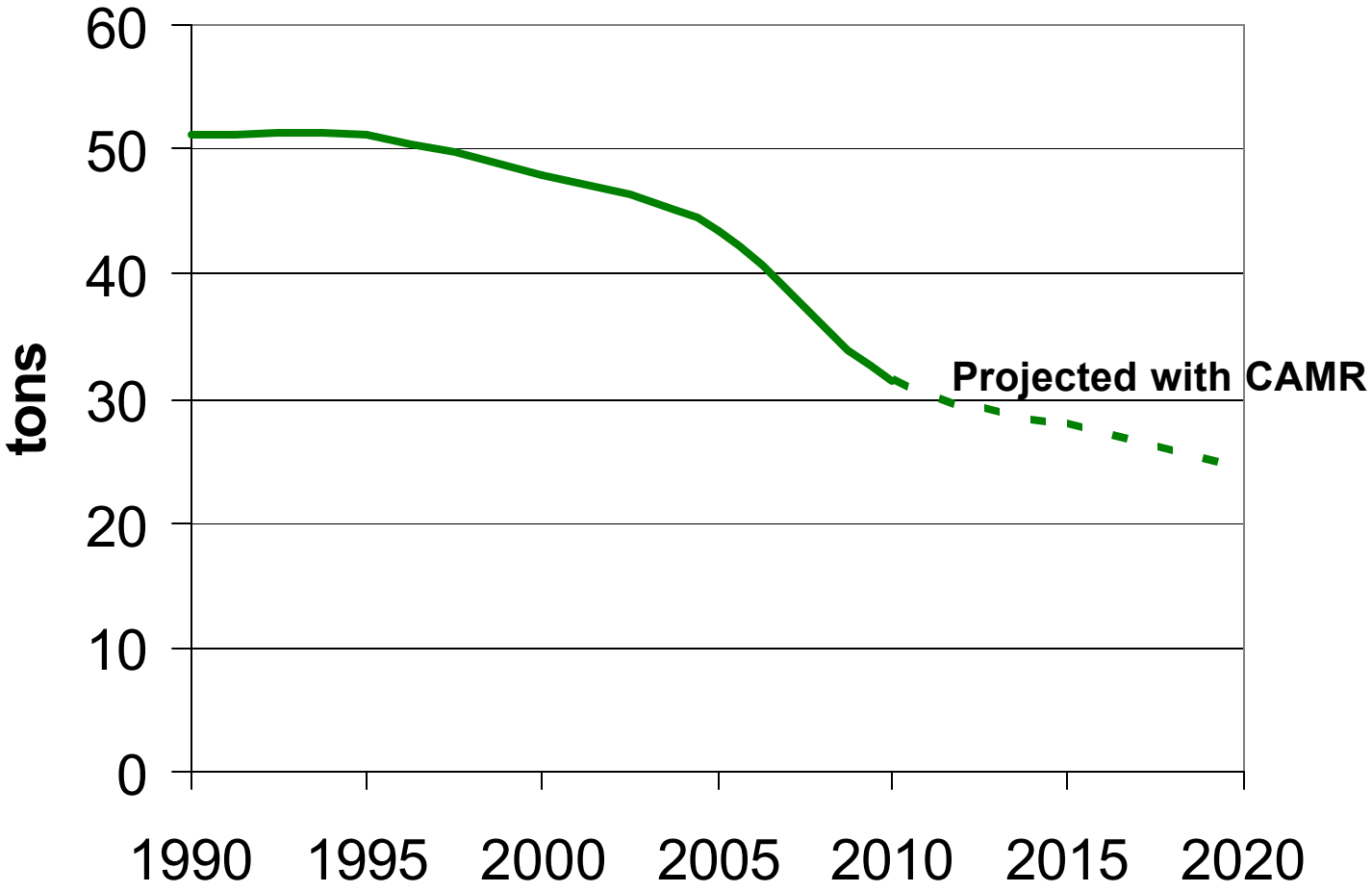
National Hg Power Plant Emissions: Historic and Projected with CAMR

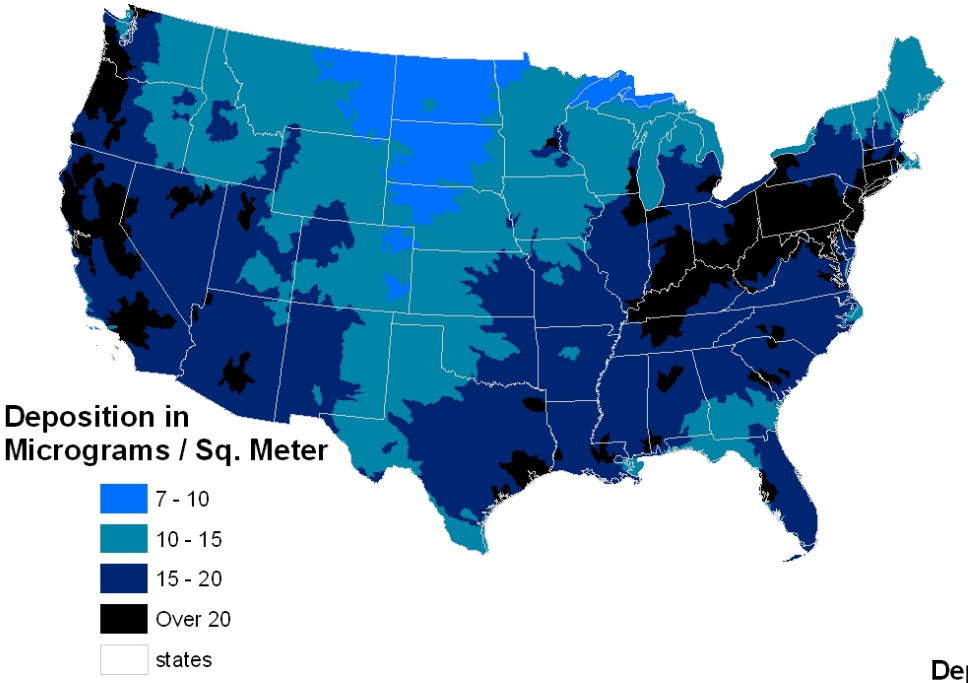


Source: EPA

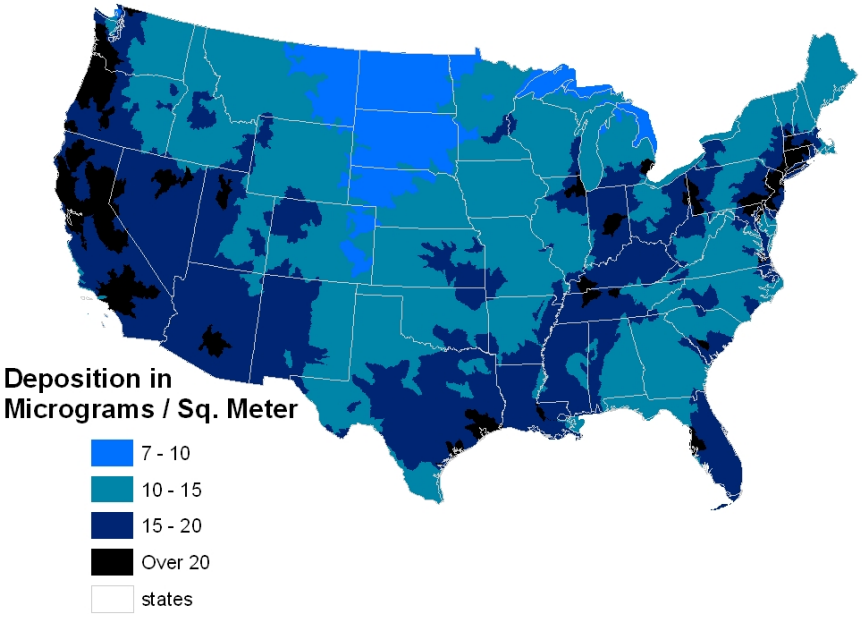
Note: 1999 emission estimate for utility coal boilers is based on 1999 Information Collection Request (ICR); 1990 and 1996 are based on different methodology.

Total Mercury Deposition

Deposition From All Sources in 2001



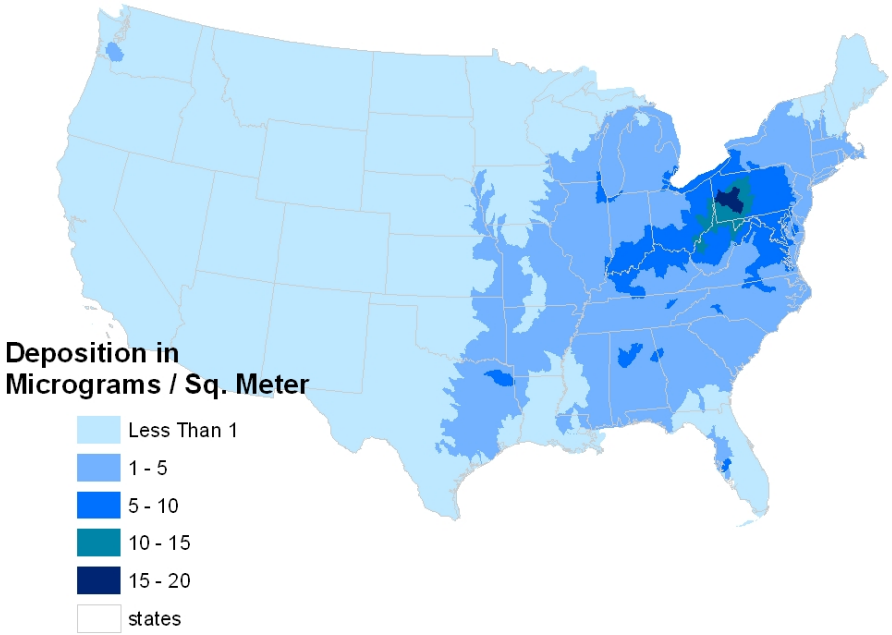
Deposition From All Non-Utility Sources in 2001



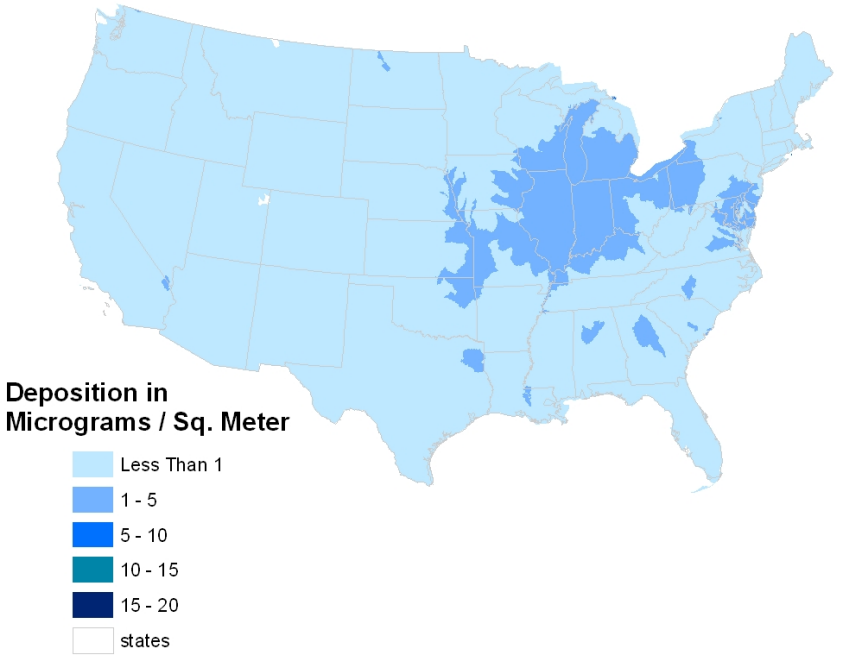
Source: U.S. EPA 2005

US Power Plant Mercury Deposition

Deposition From US Power Plants in 2001

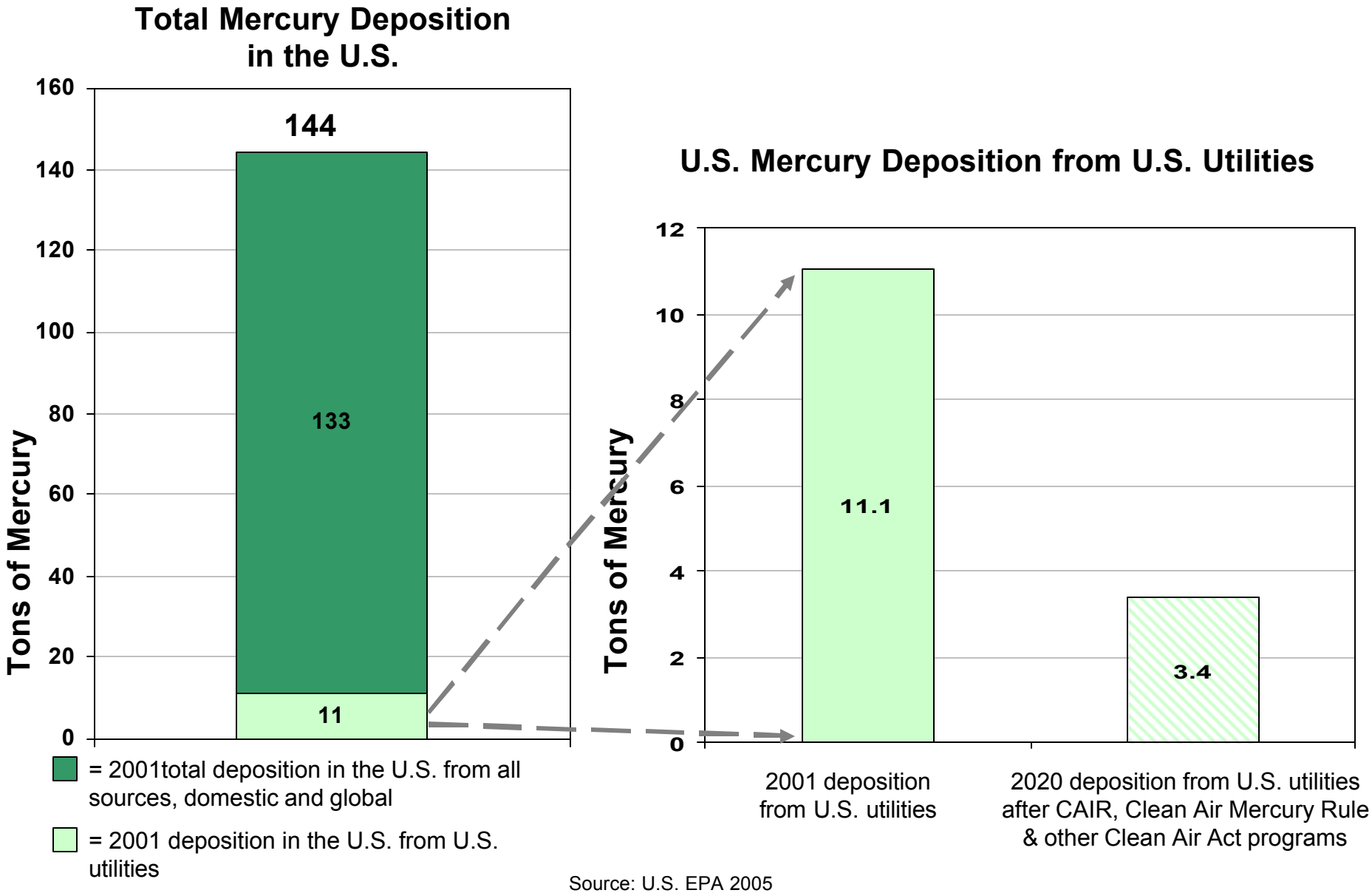


Deposition From US Power Plants After CAIR, CAMR, and Other Clean Air Act Programs in 2020



Source: U.S. EPA 2005

Mercury Deposition in the U.S.



Source: U.S. EPA 2005

Estimating Health Benefits of CAIR/CAMR

- Model extent of power plant Hg emissions before & after CAIR/CAMR
- Model resulting reduction in utility-attributable Hg deposition
- Estimate utility-attributable fish MeHg levels before & after CAIR/CAMR
  - assume proportional to deposition reduction
- Generate assumptions about recreational & high-end fish consumption rates
- Estimate utility-attributable MeHg exposure before & after CAIR/CAMR
- Estimate likelihood that exposure exceeds RfD before & after CAIR/CAMR

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Health Benefits of CAIR/CAMR

- People still potentially at risk from power-plant-attributable MeHg will be 99th %ile recreational fishers & average Native American subsistence fishers eating solely freshwater fish contaminated at the 99th %ile level
- Because the likelihood of such a scenario is poor, EPA concluded that remaining power-plant-attributable mercury emissions are not reasonably anticipated to pose a risk to human health

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Economic Benefits of CAIR & CAMR

- Based on avoiding IQ decrements, estimated benefits of reducing exposures to recreational freshwater fishers = $0.2-2.0 million/year
  - IQ decrements not actually demonstrated
- Net cost to society but will significantly reduce domestic Hg emissions
- Cost of Hg exposure falls disproportionately on people eating large amounts of recreationally caught freshwater fish

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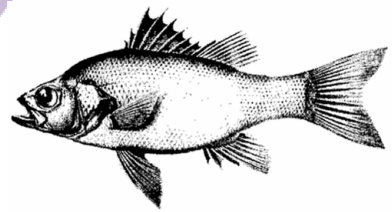
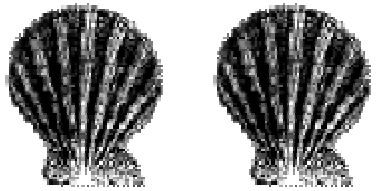


Conclusions



- Most of our MeHg risk comes from fish not impacted by US power plants
  - >75% is imported, 50% comes from a can
  - non-US Hg sources impact US freshwater fish
- US power-plant-attributable MeHg risk unlikely after CAIR & CAMR
  - But risk from non-US-power-plant sources still possible
- According to CDC, current US Hg blood levels do not pose a risk to health

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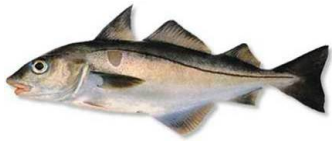
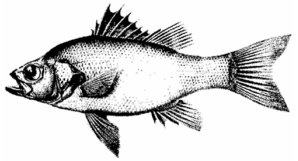
Recommendations

- Eat your fish!!
  - Demonstrated developmental & cardiovascular benefits of eating fish
- If pregnant or could become pregnant, eat at least two fish meals/week but choose low-MeHg fish
- Feed children at least two low-MeHg-fish meals/week
- Remember: benefits of fish outweigh potential risks from trace contaminants
  - Critical to brain development: omega-3 fatty acids, calories, antioxidants

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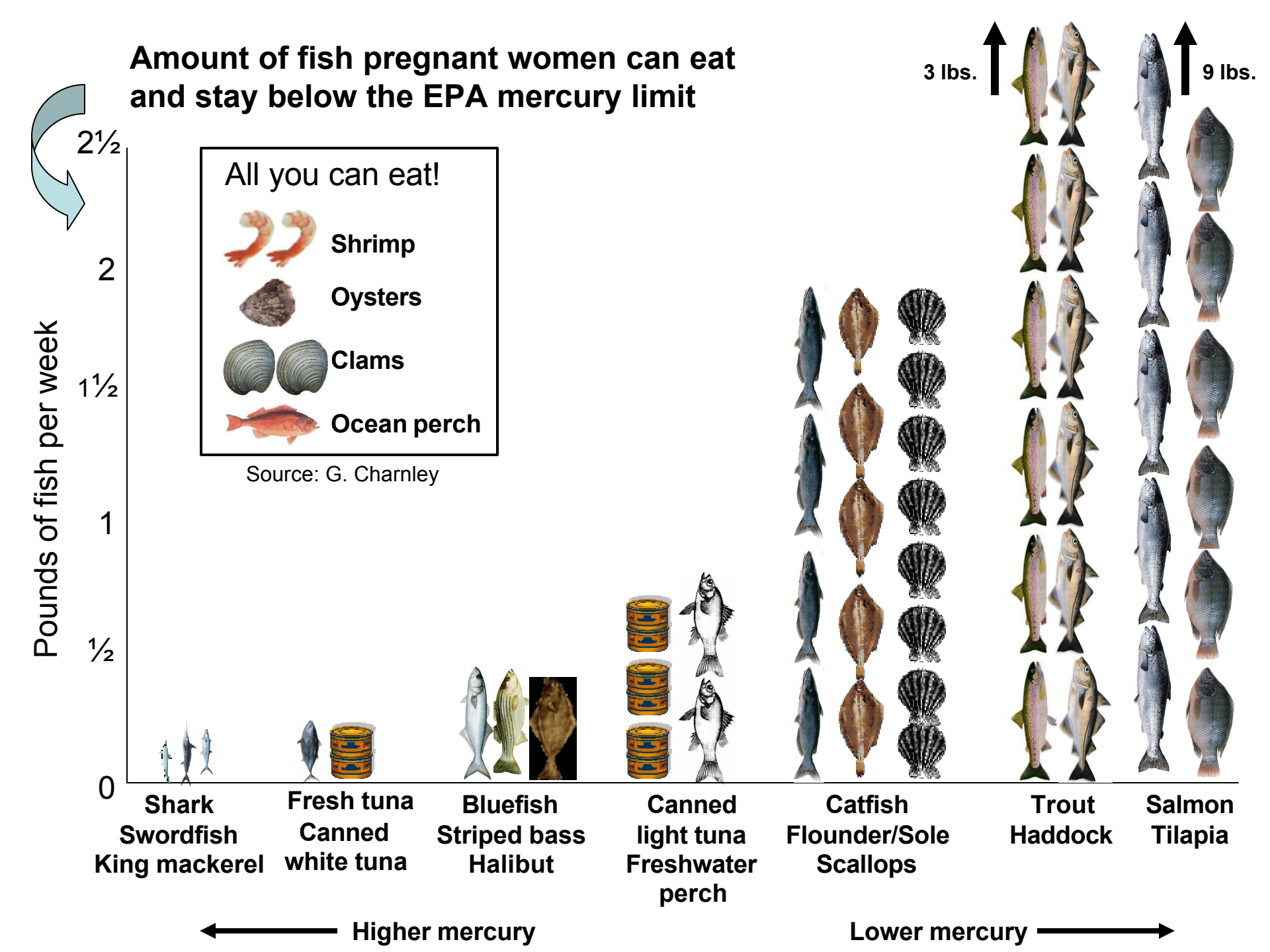
Amount of fish pregnant women can eat and stay below the EPA mercury limit
All you can eat!
Shrimp
Oysters
Clams
Ocean perch
Source: G. Charnley
Pounds of fish per week
2½
2
1½
1
½
0
3 lbs.
9 lbs.
Shark
Swordfish
King mackerel
Fresh tuna
Canned white tuna
Bluefish
Striped bass
Halibut
Canned light tuna
Freshwater perch
Catfish
Flounder/Sole
Scallops
Trout
Haddock
Salmon
Tilapia
Higher mercury
Lower mercury